CHEMICALS

Project Fact Sheet

Novel Membrane Reactor for the Desulfurization of Transportation Fuels

Benefits

- Fast desulfurization kinetics - complete reaction in less than 10 minutes.
- Mild operating conditions - below 575 °F and 200 psig H_2 pressure.
- Uses only 1.5 SCF H_2/BBL for every 500 ppm sulfur removed.
- No octane loss when used for naphtha desulfurization.
- Lower capital and operating costs than conventional hydrotreating.
- Sulfur removal to 6 ppm for diesel.

Applications

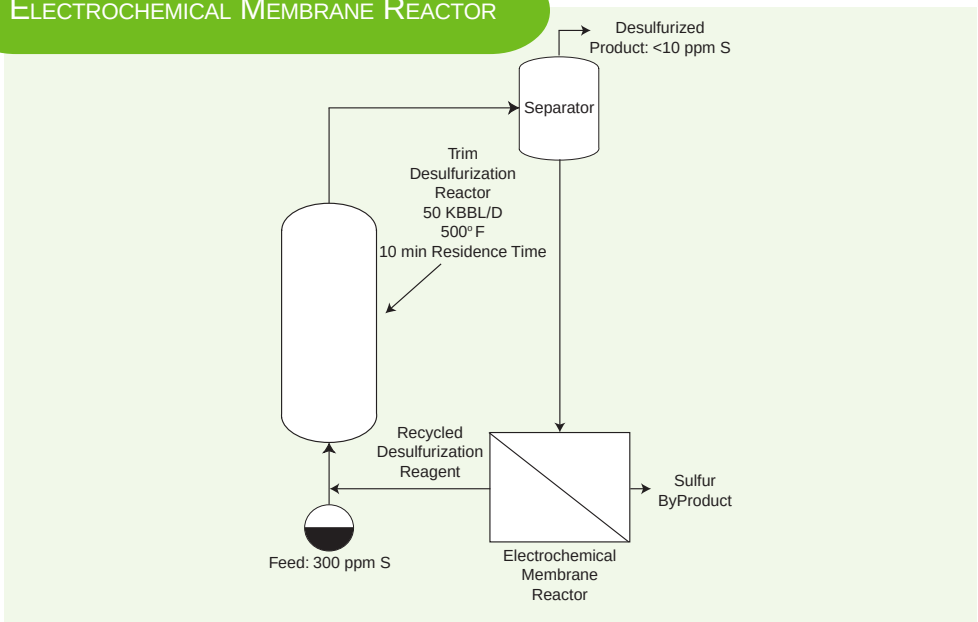
The electrochemical membrane reactor proposed has applications ranging from the desulfurization of gasoline, diesel, vacuum gas oil (catalytic cracker feed) and heavy oil, to the clean up of liquid hydrocarbons for use as a source of hydrogen in fuel cells. The electrochemical device, apart from its ability to function as a membrane reactor, can also provide power to electric or hybrid electric vehicles. Additionally, it can be used effectively for electric utility load leveling on a large scale (less than 10 megawatts).

New process gives refiners a more cost-effective route to ultra low sulfur gasoline and diesel

The production of ultra low sulfur gasoline and diesel, at a sustainable long-term cost and in quantities that will continue to meet U.S. demand, is one of the most significant challenges faced by the refining industry. Sulfur in fuels is directly responsible for increased levels of NO_X in exhaust gases and is a poison for many of the new catalytic converters being introduced by automakers. Paradoxically, supplies of crude oil have increasingly higher sulfur levels. As a result, refiners must hydrotreat feeds more severely just to remain at current sulfur-content levels. Federal mandates limiting the sulfur content of gasoline to 30 ppm will require the development of new, cost-effective sulfur reduction technology to provide alternatives to refiners in the 2006-2010 time frame.

This project is focused on the development of a novel electrochemical membrane reactor and desulfurization process that is capable of reducing the sulfur content of gasoline to 30 ppm and diesel to 15 ppm. The process has already been shown to reduce the sulfur in diesel from 300 ppm to 6 ppm under milder conditions than those found in commercial distillate hydrotreating systems. The membrane electrode assembly tested in the first phase of the project will be scaled up to commercial size in the second phase.

Electrochemical Membrane Reactor



The project team is developing the novel fuels desulfurization process shown above.

Project Description

Goal: The goal of this program is to develop a unique electrochemical membrane reactor that can be used as part of an overall desulfurization system to produce ultra-low sulfur transportation fuels. The economics of this process depend on the successful commercial development of an electrochemical device that regenerates the sulfur-removing stoichiometric reagent.

The key to successful development of this technology is the deposition of ultrathin layers of a dense electrolyte film that is the heart of the electrochemical membrane reactor. Thinner films allow more rapid transport of ions and thus allow a substantial reduction in the size of the membrane reactor. Demonstration of successful deposition techniques and fabrication of a single cell device is expected to be achieved by the spring of 2003. The ultimate product of the second phase program is a full size 5 kW device which will be suitable for testing in a pilot plant. In tandem with the membrane reactor development, the primary investigator will determine the kinetics of the desulfurization reaction and develop a detailed kinetic model. All components of the desulfurization system will be demonstrated by the end of the program so that field testing can begin.

Progress and Milestones

The following are technical objectives that were achieved in the initial stages of research:

- Demonstrated that a proprietary stoichiometric reagent is capable of reducing the sulfur level in a standard diesel fuel from 298 ppm to 6 ppm.
- Demonstrated that kinetics of the desulfurization reaction are much faster than previously thought (reaction is complete in less than 10 minutes at 200° C).
- Demonstrated that thin dense films of electrolyte could be deposited on one microporous support.

Current research is focused on achieving the following milestones:

- Determine the single best microporous support for supporting the thin electrolyte layer.
- Demonstrate that defect-free thin films of less than 25 microns can be deposited on the microporous support.
- Scale up the size of the supported electrolyte from tubes 2 inches in length to commercial size tubes 12 inches in length.
- Complete kinetic studies on a range of petrochemical streams to demonstrate the flexibility of the technology and to develop a comprehensive mathematical model for desulfurization.

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